U. S. FOREST SERVICE
Gallatin National Forest

SPRUCE BUDWORM CONTROL PROJECT

GARDINER UNIT
1955

By: W. H. Ibenthal

GARDINER SPRUCE BUDWORM CONTROL PROJECT

GENERAL DISCUSSION:

Pre-control Survey

The first step in deciding upon a spray area should be to get an FIR appraisal of the probable satisfactory boundary from an entomological point of view. Having set the satisfactory boundary, the private land contribution question must be trial tested. If cooperation is expected, mapping should begin and be finished considerably ahead of the probable spraying date. The mapping should be a late fall season job because if left until spring it is probable that snow depth will interfere with travel. The mapping can be done to a large extent by air methods, if the air mappers have on-the-ground experience in the vicinity of the mapping.

The area computations, the plan of checking the spraying, the details of transportation of personnel, and details of communication must be worked out and co-ordinated well ahead of the time spraying is to be started. The FIR job of keeping tab on development of larvae and mortality must also be well planned and the planning should be completed ahead of probable spraying dates. These plans will require on-the-ground knowledge of the area and conditions by a considerable number of people and will cost real money.

Aerial Photographs, Mosaics, and Spraying Maps

Aerial photographs and mosaics of the area to be sprayed are a very real help and a necessary working tool. On the Gardiner unit we used aerial prints for a variety of purposes including the computations of areas where sectionalizing was possible. The computations probably were fairly accurate. Where sectionalizing was not possible, the aerial computations could only be a reasonable approximation. Such computations would not be on good footing in an audit review and on less favorable ground in a complaint case by the flying contractor. Spray plane pilots can and do use aerial photographs. It should be remembered that aerial photographs are taken from very high elevations and the spray plane pilots' view of an area is from a much lower altitude. If no aerial photographs were available, it would be more practical to block the country to be sprayed by drainages, take oblique pictures of the drainages, and use the obliques for spray plane pilot instruction. The best combination of photographs would be aerial pictures to determine base map outlines, aerial pictures with section corners located, the types from aerial pictures then transposed to a four or eight inch per mile base map for area computation and other payment settlements. Oblique photographs with block boundaries plainly marked in heavy ink or crayon would seem to be the best pilot instruction pictures that could be used.

Spray Blocks and Spraying Techniques

There is considerable to be gained in holding the same pilot in the same general area during the spraying operation. This general area may be divided into small sub-blocks and progress from block to block designed so that checking can be more easily done. The size of the block could be correlated somewhat with the type of spray plane equipment used. If large planes were used in spraying, the blocks could be large enough to provide several days work. An orderly progress of movement between sub-blocks would then allow for satisfactory checking on the ground. Any progressive plan for spraying is certain to be interrupted during the spraying operations due to weather conditions, an incapacitated plane or pilot, or due to urgency of other areas because of early larvae development. Block boundaries can well be set by the project supervisor. They may not be followed by the flying contractor because of special considerations which he has to consider. These cases would be in the minority and it would advance the planning job considerably to have the blocks designated prior to the beginning of spraying even though the type of plane and the capabilities of the plane were not known at the time of blocking. The methods of flight and the spray flight lines should be left to the contractor, his chief pilot, or the spray plane pilot. On the Gardiner unit the spraying was done on a gypo type basis by the spray plane pilots. The chief pilot, of necessity, had to arrange blocks, ferrying time, and other flying particulars between pilots to keep their earnings somewhat equitable and to consider the capabilities and peculiarities of each man in his pilot crew.

We have one suggestion on flying techniques which we think is worth discussion. This is to abandon the relatively low level flying now being practiced and expect delivery of the insecticide in about the same size droplets, but in much greater volumes during only the most favorable spraying weather. By the most favorable weather is meant that period, every year and on the days when there is a definite downward movement of heavy air. Spraying would, of course, be restricted to less total hours per season than is now being used. The volume of spray delivered would be considerably increased, the swath covered by each flight line would be three or four times as great, and the possibility of skips in spray swaths would be materially reduced. The possibility of accidents would be reduced slightly and larger planes could be used for much more of the spraying terrain than is now possible. It is believed that flying at four hundred or five hundred feet above the level of the trees would be possible and we would get a much more even distribution of spray and much less chance for skips in spray swaths.

Spray Checking

The FIR people are responsible for spray checking standards and accomplishments. It would seem that definite check lines, pre-planned, would help to get a statistical base for better judging the effectiveness of the job.

Vegetative examination is probably as good as card checking providing it is done by a person with enough experience to evaluate what he sees. The whole checking job could well be done by fewer and more capable people. Due to the distances and time elements involved in getting to locations, good organization indicates that a leader of a checking crew could not well supervise more than two or possibly three assistants of little experience.

Size of Spray Planes

The critical factor in spraying is time; that is, those few hours during the year when a satisfactory job can be done. Large planes that fly fast and put out the most gallons per minute are the best bet. Really good downward falling air is a critical factor. It is limited to a good deal less than four hours per day in Eastern Montana. The time spent ferrying to and from the field with a load of insecticide is time lost. Higher flying with a much larger swath on perfect air with large planes would seem to be the only answer. The quality of the finished spray job is probably limited as much by poor air as by any mistakes pilots might make in swath widths. Air strips should be located close to the operation or preferably in the center of operation. Planes of different sizes cause confusion, lost time, and probable accidents when used on the same field. During the Gardiner operations with over 1100 flights in less than three thousand minutes, smoothness of air field operations was very important because bunching of planes in the field or in the air is bound to occur. When planes of different landing, loading, and take-off requirements are working on the same strip, more time is needed on the air field per plane, consequently less spraying can be done. We had no troubles or delays in servicing planes with gasoline or insecticide. With restricted air strip room, it could very well happen that the loading, landing, and take-off space would be so limited that considerable time would be lost on this job. Any time lost at the air strip means further reduction in the possible spraying time per year. Likewise, too many planes on a field may require stacking the planes for landing and considerable lost time in refueling and take-off. The peculiarities of ground conditions on each field will determine the amount of time which may be lost at the field.

Insect Control Organization

The FIR branch has the responsibility of determining the areas which are suitable for control, the development of the insects, and the results of the spraying operation. In order to tie the administrative Forest Service organization with the total job, it would seem that the mapping within the entomological unit of what to spray and what not to spray should be done by the administrative branch of the Forest Service. The FIR would inform the administrative branch when the area was ready for spraying and when no further spraying should be done because of insect development. The administrative branch of the Forest Service should check the spraying

job; in other words, attend to the contract requirements. The procedures for checking and the acceptable limits of a satisfactory job should be set by the FIR. After completion of the spraying job, the FIR could make a survey of budworm populations and evaluate the effectiveness of the control work. This would place the enforcement of the contract and the completion of the contract in the hands of the administrative branch and would require considerably fewer personnel by the FIR branch and their work would be confined to the purely technical phases of entomological units, larvae development, and effectiveness of control measures. Such an arrangement of work would require considerably less co-ordination and considerably less cooperation than is required under the present setup on a control unit.

Contracts

Any spray project setup should have the minimum acceptable job and the procedures to be followed defined by the Regional Forester and from that point onward, the forest administration should take care of the job. The results of the effectiveness of the spray control project could be determined by the FIR people checking insect populations after the job was finished. In 1955 there did not seem to be any clear idea of what procedures were to be followed, what the standards were for a minimum acceptable job, or any idea of what this might cost. The contract conditions enforcement should be the job of either the FIR or the Forest Service. Since the administrative branch is making the contract, they should have the administration of it. The present contract says, "The flying contractor shall apply one gallon per acre of insecticide in a uniform manner. Checking stations shall be maintained in all areas as the insecticide is applied. Any inadequacies in insecticide distribution shall be corrected without expense to the Government." The 1955 plan of organization on the part of the administrative branch had no provision or intention of complying with the Government's checking of the contract conditions. This one condition would have made it impossible to win a complaint with the flying contractor if complaints had arisen. Either more realistic conditions of contracts should be written or provision should be made for the Government to carry out its side of the agreement. Obviously, the checking of the entire acreage is impossible. It is appreciated that contracts for a job of this kind are very hard to write on an equitable base so that new people are encouraged to enter the business. A contractor may supply a large number of small planes or a smaller number of large planes and still meet the conditions. In any type plane used, it is probable that he would not have properly judged the topography or the weather and not have enough equipment on hand to finish the job. If we were to be sure of enough equipment to finish the job, the contract should state that the contractor must furnish enough equipment to cover a certain number of acres per hour and hour limitation should be restricted to about seventy-five percent of the hours which are expected to be available for spraying.

The contract, as used in 1955, stated that the contractor should furnish an observation plane for joint use. If 1955 experience is an index, the administrative officer should have an observation plane for his use without use by the contractor. It should be equipped for radio communication with the air strip. The 1955 contract required a chief pilot for the project. On the Gardiner unit the chief pilot worked harder, longer hours, under more strain by a whole lot than did the spray pilots. The spray pilots are regulated in the time that they may put on the job by contract conditions. Good organization would indicate that one chief pilot should be provided for at least each five spray pilots. The spray pilots are limited to five hours flying per day, much of which is spent going to and from their block and in refueling at the air field. The chief pilot works at least twice as many hours per day. When a pilot cannot be carried for his observatory work due to plane load limitations, the chief pilot must do a good deal of flying, a good deal of map reading, and at the same time, tend to the administrative duties required of the spray plane pilots.

The insecticide contract appeared to be satisfactory all the way through during the 1955 season. Furthermore, the conditions of the contract were adequately and accurately checked in the insecticide contract. Performance was adequately and accurately checked and could be made a matter of record. This contract is one that could stand up under the scrutiny of any auditor or any complaint by the contractor. It would be extremely desirable if the flying contract could be worded in a way that would allow for the same accuracy of control and the same sort of record keeping that is possible in the insecticide contract.

Cooperative Work

The 1955 program in the Gardiner area involved a small proportion of private land. It is not too different from other private land cooperative programs that may be expected on the east side of the Continental Divide. This private land is used for grazing purposes and while the ranchers value their tree crop as a source of poles, logs, and farm building materials, these ranchers do not ordinarily consider the sawlog value of their timber crop or the potential value of the young growth.

In the Gardiner area there was no reluctance to cooperate on the spraying program providing the neighborhood participated and providing it would not cost too much. These rough range lands (they are so considered by the ranchers) are worth very little per acre, probably not over $5.00. They would not continue to spend $1.00 per acre per year on budworm control if they knew that the program would be a continuing one. There were two outstanding "ifs" in rancher contacts. Ranchers would pay if their neighbors did. Ranchers would pay if we considered the acreage to be sprayed on their estimate of acreage in need of spraying. For instance, it might be practical to spray 160 acres of a rancher's range land, but the rancher only considered he had a total of 60 acres of trees in need

of spraying on the 160 acre tract, and he was unwilling to forfeit the point even thoug he only made a token payment for the land sprayed. This is conducive to many arguments that will get the interviewer nowhere when contacting ranchers. The State Forestry people did most of the actual work of collection within the Gardiner unit. The writer believes that Mr. Marks, who did the work here, had the right approach and did not stir up any controversies in the neighborhood in his contacting work.

I & E Aspects

The writer believes that the I&E aspects of a spray program should be carried on by a person specifically assigned to that job with no other duties during the time that the project is in operation. It is very easy for the project supervisor to spend a large portion of his time talking to visitors, the general public, and visiting officers during the spraying operations when all his attention should be directed to the administration of the job itself. A group of airplanes laying down spray is somewhat of a spectacular project and the visitors on the job are more numerous than on most other forest jobs.

Project Costs

All of the suggestions for improvement in the execution of the contract are pointed at higher cost. It may be possible to let a contract whereby all the responsibility of killing the larvae is assumed by the contractor. If this were possible, the only administrative functions would be to check mortality and pay off on the basis of percentage killed. To do this and reduce administrative costs to a negligible amount would greatly increase the contract cost, if indeed anyone could be found who would accept such a contract and bond himself for it. There does not seem to be any way to increase control to an acceptable point without an increase in cost.

The administrative costs on the Gardiner project were considered too high. The facilities, personnel, checking in compliance with the contract, and other phases of the job were considered inadequate by the project supervisor. To make them adequate would further increase the cost. The big question to be decided by the project supervisor when contracts are accepted and spraying is to be done is whether he will spray during the small amount of available time with the facilities and information at hand, inadequate though it may be, or whether he will insist upon better facilities, better checking, closer compliance with contract conditions, and thereby waste a good deal of the very limited time available for spraying and possibly run into difficulty and complaints from the contractor because he impeded the job.

The contractor on the Gardiner job lacked a good many of the requirements he should have provided had he intended to follow the contract in good faith. Planes were not available for inspection when called for. Field

operation officers were not available when called for, in fact, this job was combined with the chief mechanic's job. The observation plane, of necessity, had to be used by the chief pilot when it would have been advisable to be free for use by the project supervisor. There were many little shortcomings in contract compliance, such as instruction room for the pilots, supervision on the ground of pilots, airfield facilities for pilots which were inadequate. Some of these facilities were furnished in part by the Forest Service. It would seem to be the contractor's job to supply these.

Finally, the project supervisor must count the probable time of flying, the probable rate of insecticide distribution, and do the best he can with what he has to work with at the time the larvae are right for spraying and the air is right for distribution of the insecticide or abandon completion of the job for the season.

GARDINER SPRUCE BUDWORM CONTROL PROJECT

1955

SUMMARY:

Decision to establish a control area made on April 28. 1955

Air strip site selected and work began on May 24. 1955

Exterior mapping of control unit began on June 1. 1955

Mapping of areas to be sprayed within the control unit began on June 20. 1955

Air strip reconstruction finished June 30.

First of spray planes arrived July 1.

Spraying operations began on July 5.

Spraying ceased on July 20 covering:

55,412 acres in Yellowstone National Park

5,152 acres of private land

72,292 acres of National Forest Land

77,444

132,856 TOTAL ACRES

GARDINER SPRUCE BUDWORM CONTROL PROJECT CONTINUED

The COST of the completed project is as follows:

$ 46,060.00 for application of the insecticide.

$ 63,896.00 for purchase of insecticide.

$ ~~14,957.59~~ for construction of air strip.

$ 3,213.67 for maintenance of air strip.

$ 3,522.94 for wages of facilitating personnel.

$ 1,262.74 for project communications.

$ 1,012.90 for supplies and equipment.

$ 10,156.85 for checking the effectiveness of spray F.I.R.

$144,082.69 TOTAL COST

$1.0845 COST PER ACRE

Effectiveness of spraying job judged in late July and August as 90 plus percentage of mortality of feeding budworm larvae.

GARDINER SPRUCE BUDWORM PROJECT

BLOCK NO.	BLOCK NAME	GROSS ACRES	NET ACRES	PILOTS
1	Cedar Creek	2,455	2,155	Wheat 1
2	Devils Slide	1,950	1,890	Brown, 2 Hudson 3
3	Yankee Jim	1,306	1,276	Ducrest 4
4	Tom Miner	4,649	4,389	Edgecombe 5
5	Electric Creek	1,564	1,444	Brown
6	Mol Heron Bottom	797	797	Cleven 6
7	Stevens Creek	2,975	2,875	King 7
8	Cottonwood Creek	1,648	1,648	Kellogg 8
9	Cinnabar	1,523	1,403	Schmidt 9
10	Lower Reese Creek	3,356	3,196	Cleven
11	Upper Mol Heron	4,673	4,553	Wheat
12	Electric Peak	3,093	2,843	Kellogg
13	Pine Creek	2,861	2,620	Brown
14	Palmer Creek	1,112	1,000	Ducrest
15	Crevice Ridge	1,472	1,472	King
16	Crevice Road	2,933	2,733	Ducrest
17	Decard Flat	1,926	1,726	Dobrinski 10
18	Crevice - Cottonwood	1,885	1,785	Schmidt
19	Dome Mountain	2,688	2,338	Brown, Edgecombe
20	East Crevice	1,441	1,381	Cleven
21	Mammoth	3,010	2,760	Hudson, Wheat
22	Big Cottonwood	1,766	1,496	Dobrinski
23	Little Cottonwood	1,535	1,475	Ducrest

24	Hellroaring	1,708	1,450	Kellogg
25	West Hellroaring	3,010	2,860	Kellogg, Slovak
26	Speciman Creek	2,767	2,667	Schmidt, Kellogg, Ducrest, Edgecombe
27	North Crevice	1,962	1,962	Cleven
28	Horseshoe	898	808	Dobrinski
29	Slough Creek	2,057	1,837	King
30	Mill Creek	1,305	1,305	Schmidt
31	Lion Creek	1,476	1,426	Hudson
32	Bunsen Peak	5,421	5,121	Ralston, Brown, Edgecombe, Cleven, Hudson
33	Blacktail Deer Creek	1,100	750	Ralston
34	Hellroaring Mountain	1,975	1,975	Brown, King
35	Hellroaring Creek	2,123	2,023	Brown, King
36	Lower Hellroaring	3,577	3,057	Wheat, King, Dobrinski
37	Lower Blacktail	3,965	3,715	Ralston, Hudson
38	Everts Mountain	5,854	4,654	Ralston, Hudson, Ducrest
39	East Blacktail	1,943	1,400	Ralston, Wheat
40	North Fork Bear Creek	1,915	1,615	Slovak
41	Upper & Lower Cedar Creek	2,973	2,773	Ducrest
43	Eagle Creek	2,800	2,450	Ducrest, Edgecombe, Slovak
44	Trail Creek	3,294	3,194	Dobrinski, Slovak
46	Buffalo Creek	4,820	3,710	Dobrinski, Kellogg, Wheat, Schmidt
48	Geode Creek - Garnet Hill	4,453	4,103	Ralston, Edgecombe, King, Wheat, Schmidt, Ducrest, Cleven
49	Yellowstone Canyon - Junction Butte	2,592	2,192	Ralston, Wheat, Edgecombe

50	Tower Creek-Crescent Hill	4,447	4,447	Ralston, Schmidt, Ducrest, Wheat, Kellogg, Dobrinski
51	Oxbow Creek	2,055	1,655	Ralston
52	Bassett Creek	4,784	4,584	Cleven, King
55	Upper Reese Creek	3,152	2,952	Hudson
56	Big Pine Creek	1,826	1,660	Kellogg, Schmidt
57	Little Pine Creek	2,208	2,908	Edgecombe, King
58	Upper Six Mile Creek	1,642	1,542	Brown
59	Slip & Slide Cr-Red Mountain	2,964	2,517	Edgecombe, Dobrinski, Ducrest
60	Lower Six Mile Creek	952	900	Hudson
61	North Fork Six Mile Creek	2,027	1,800	Hudson, Cleven, Ducrest
62	Gold Prize Creek	1,749	1,589	Dobrinski, Wheat
	TOTALS	144,412	132,856	

Of the Total Acreage: 55,412 is within Yellowstone National Park

5,152 is private land

72,292 is National Forest Land

TABLE #2

Date July	First Plane Out	Last Plane Out	Minutes Flying Time	Planes in Use	Gallons Carried	Number of Spray Plane Flights
5	7:05	8:37	92	7 Stearmans	1,885	24
6	4:15	8:34	259	9 Stearmans	10,905	108
7	--	--	Windy ---	Gusty --- Weather	---	---
8	4:15	7:16	181	10 Stearmans	7,692	76
9	4:24	7:04	160	10 Stearmans	6,484	61
10	4:20	9:26	306	10 Stearmans 1 TBM	16,066	115
11	5:53	7:40	107	10 Stearmans 1 TBM	4,625	43
12	4:42	10:18	336	9 Stearmans 1 TBM	10,719	63
13	4:20	8:35	225	10 Stearmans 1 TBM	13,796	100
14	5:35	8:43	188	2 Stearmans 1 TBM	4,456	23
15	4:21	8:11	230	11 Stearmans 1 TBM	14,658	105
16	4:46	6:39	113	11 Stearmans 1 TBM	7,545	54
17	4:25	6:31	126	10 Stearmans	6,705	59
18	4:22	7:44	202	11 Stearmans	9,399	81
19	4:28	8:00	212	10 Stearmans	9,114	78
20	4:26	7:46	200	10 Stearmans	7,689	66
		TOTAL	2937		131,736 TOTAL	1056
					Observation Plane Flights	55
					TOTAL FOREST SERVICE FLIGHTS	1111

48 hrs 57 min

Sample
TABLE #3

Individual trip check
Gardiner Spruce budworm Project
July 1955

plane No	Ground Connected	Pilots Name	Spray in Gallons	Gas in Gallons	Block Destination	Gas Reserve in Gallons	Safety Belt	Shoulder Straps	Crash Helment	Time of Departure	checked by
N68441 Ray Brown /15/											
7/19/55			125	F	58		x	x	x	4:35	J.N.R.
19			126	½	58		x	x	x	5:13	J.N.R.
19			125	½+	58		x	x	x	5:44	J.N.R.
19			126	½	58		x	x	x	6:20	J.N.R.
19			126	½	58		x	x	x	6:52	J.N.R.
19			126	½	58		x	x	x	7:25	J.N.R.
19			100	½	58		x	x	x	7:52	J.N.R.
7/20/55			100	½+	58		x	x	x	4:29	N.W.
20			100	½+	58		x	x	x	4:55	N.W.
20			100	½+	58		x	x	x	5:29	J.N.R.
20			100	½+	58		x	x	x	5:59	J.N.R.
20			100	½-	58		x	x	x	6:31	J.N.R.
20			102	½	58		x	x	x	7:06	N.W.
20			100	½	58		x	x	x	7:30	J.N.R.

NOTE: This form was not used exactly as designed. We found that each plane took one form and more than one plane should not be recorded on the same form.

The caption "Ground Connected" was not used. This was for gas filling only. The plane number and pilot's name was a constant on each sheet. The date of the load is recorded.

This form is used at the filling pit by the fuel and insecticide checker.

DAILY TRIP SUMMARY

July 17, 1955

PILOT	TRIPS	GALLONS
Brown	4	483
Edgecombe	7	704
Cleven	7	870
King	7	883
Dobrinski	6	600
Kellogg	5	503
Ducrest	7	880
Wheat	5	516
Schmidt	5	509
Slovak	6	757
TOTAL	59	6705

DAILY SUMMARY BY BLOCKS

July 17, 1955

PILOT	GALLONS	BLOCK
Brown	241	34
	242	35
Edgecombe	503	43
	201	19
Cleven	870	52
King	883	52
Dobrinski	600	44
Kellogg	503	25
Ducrest	440	41
	440	42
Wheat	516	36
Schmidt	509	26
Slovak	757	44

Gardiner Spruce Budworm Project
Record of Observation Plane Use
July 8, 1955

Time of: Departure	Arrival	Hours used	Purpose	Personnel
5 p.m.	5:30 p.m.	.4	Blocking	Allison - Ibenthal
5 a.m.	5:45 a.m.	.7	Observation	Cooper - Wortman
		1.1	Check calibration	Isler - Allison
		.7	Checking	Allison - Ibenthal
	TOTAL	2.9		

NOTE: This form was satisfactory. Information was recorded each day from plane tachometer. This is a typed sample of the use of one of these forms.

Signatures

Authorized by /s/ Wm. H. Ibenthal

Approved by

TABLE #7

Gardiner Spruce Budworm Project
Record of Insecticide Used by Blocks

Page # (Not used)

Block #40 - North Fork Bear Creek

Date	Plane Number	Gallons Sprayed	Block #	Cumulative Total in Block
July 14	8	855	40	855
July 15	8	880	40	1735
July 16	8	125	40	1860

GARDINER DAILY WEATHER REPORT

STATION Camp 1 STATION

DATE 7/4/55 DATE

HOUR	WIND	CEILING	TEMP	HOUR	WIND	CEILING	TEMP
0800	2-3 mph W	overcast unlimited	68°				
0815	1 mph W	"	75°				
0830	1mph W	"	"				
0845	--	"	"				
0900	1 mph W	"	"				
0915	2 mph W	"	77°				
0930	5 mph W	"	73°				
0945	1 mph W	"	74°				
1000	2 mph W	"	74°				
1600	5 mph NW	"	84°				

PREDICTION FOR TOMORROW

TODAYS SUMMARY

GARDINER DAILY WEATHER REPORT

STATION Camp 2 — DATE 7/4/55

HOUR	WIND	CEILING	TEMP
0300	--	7000	38°
0315	--		38°
0330	--		38°
0345	--		38°
0400	--		38°
0415	--		"
0430	--		"
0445	--		"
0500	--		"
0515	--		"
0530	--		"
0545	--		"
0600	--		42°
0615	--		48°
0630	--		48°
0645	--		50°
0700	--	8000	50°
0715	--		50°

STATION Camp 2 — DATE 7/4/55

HOUR	WIND	CEILING	TEMP
0730	--		50°
0745	--		50°
0800	--		54°
0815	--	unlimited	56°
0830	--	"	"
0845	--	"	58°
0900	--	"	60°
0915	--	high overcast	60°
0930	1½ m.p.h. SE	"	60°
0945	--	"	60°
1000	--	"	"
1600	5 m.p.h. SW	"	68°

PREDICTION FOR TOMORROW

Broken to scattered clouds with bases near 7000 MSL, winds mostly southeasterly 3-6 MPH, shifting to northwesterly 8-10 MPH about 10 a.m. Temperature will climb from 35° at 3:00 a.m. to 55° at 9:00 a.m. Light rain showers in vicinity.

TODAYS SUMMARY

Low scattered clouds about 7000 lifting about 7:00 am. No winds. Temperature raised from 38° at 3:oo a.m. to 60° at 10:00 a.m.

NOTE: This form was satisfactory and would serve as a basis for analysis if needed.

TABLE #9 (A)

SPRAY AIRCRAFT INSPECTION

7/10/55

Contractor Central Aircraft - Yakima, Washington

Plane No. N7922A Make TBM

Pilot Swede Ralston Owner Ball - Ralston

TANK: Exterior filler cap x Green color

Maximum allowable load 680 Gals. Marked "spray"

Gauge or stick Vent size

Dump valve, size 1-10"d - 1-2"d Area, sq. in.

Control in cock pit x

$\frac{\text{Load in gals.}}{\text{Area, sq. in.}} = \frac{\quad}{1}$ $\left(\frac{7.65}{1}\text{ single }\frac{9.6}{1}\text{ multi.}\right)$

PUMP: Type and size $7\frac{1}{2}$ h.p. engine & Pacific Pumping Co. $1\frac{1}{2}$ BD-LVE pump

Pressure (at least 25 psi) ? Gauge x

directed down
46 NOZZLES:/ Make and size S. systems 1/8" pipe size diaphragm checks with caps removed

Positive shut-off S. systems diaphragm checks

AIRCRAFT

Engines (single, 450 h.p.) 2000 h.p. (Multi, 900 total h.p.

Hours (min. 15; max. 700) x

Hours past 60 da. (min. 15) x

Shoulder harness x Safety belt x and chute

Gas tank cap (red) x Crash helmet x

Remarks: Qualifications of aircraft and pilot checked and approved by A. Gieser per telephone conversation 7/9/55.

400 swath - 150 m.p.h. C. Sutliff and D. Isler

120 g.p.m.

/s/ D. A. Isler

TABLE #9 (B)

SPRAY AIRCRAFT INSPE TION

7/5/55
#9

Contractor Central Aircraft

Plane No. N57049 Make Stearman

Pilot Kellogg Owner Central

TANK: Exterior filler cap x Green color x

* Maximum allowable load 100 Gals. Marked "spray" no

Gauge or stick x Vent size 1½

Dump valve, size 5" diameter Area, sq. in. 19.625

Control in cock pit x

$\frac{\text{Load in gals.}}{\text{Area, sq. in.}} = \frac{5.5}{1}$ $\left(\frac{7.65}{1}\text{ single }\frac{9.6}{1}\text{ multi.}\right)$ o.k.

PUMP: Type and size simplex 1¼ x 1 Brake (wind drive) x simplex

Pressure (at least 25 psi) x Gauge x

NOZZLES: Make and size King - 1/8" orifice - 20

Positive shut-off x King diaphragm check valves

AIRCRAFT

Engines (single, 450 h.p.) 450 h.p. h.p. (Multi, 900 total h.p.

Hours (min. 15; max. 700) 100

Hours past 60 da. (min. 15) o.k.

Shoulder harness x Safety belt x

Gas tank cap (red) x Crash helmet x

Remarks: * with full gas

21.0 gallons per minute - o.k.

Gardiner spruce budworm Project

Daily fire and Safety Inspection Record
July 20, 1955

Insecticide Contract

1 - CO^2 at pumping unit o.k.
1 - CO^2 at each nozzle o.k.
No leaks in pumping equipment or tanks. o.k.

Spraying Contract

Plane ground in place at filling pumps o.k.
1 - CO^2 at gasoline loading stations o.k.
1 - CO^2 at plane maintenance stations o.k.
1 - CO^2 for each three planes at parking stations o.k.
2 - CO^2 in emergency truck o.k.
1 - Ambulance truck containing:
- 1 - Stretcher o.k.
- 2 - blankets o.k.
- 1 - 10 to 25 man first aid kit. o.k.
- Emergency tools to release men from plane wreckage. o.k.

Working area clean and neat. o.k.

Inspected by: /s/ John N. Root

TABLE #11

Gardiner Spruce Budworm Project
Mechanical Inspection Record

Plane Number 56464 July 19, 1955

1. Propeller (Engine)	o.k. /s/ B.W.	
2. Fuel strainer	o.k.	
3. Fuel and oil quanity - (filler caps secure)	o.k.	
4. Tires, wheels and brakes	o.k.	
5. Landing gear struts (Main and tail)	o.k.	
6. Insecticide tanks (Leakproof)		Leaking (then okayed by G.G.S.)
7. Dump valve and control	o.k.	
8. Spray system (Boom pump Nozzle)	o.k.	
9. Windshield (clean and unbroken	o.k.	
10. Control surface covering (No holes or tears)	o.k.	
11. Wings - covering and bracing	o.k.	
12. Magnetic oil sump plug - removed and replaced	o.k.	

Pilot Remarks: Goop tank leaking in same place as before.
R.h. side - top of tank.
O.K. - Tank welded - /s/ G.G.S.

NOTE: All items 1 - 12 were initialed by B.W. Then the whole sheet was checked and initialed by G.G.S.

Signature /s/ G. G. Scheuffele Mechanic
Signature Forest Officer

GARDINER SPRUCE BUDWORM CONTROL PROJECT

Description of the Area Treated

The Gardiner Unit is generally confined by a high range of mountains on the east and south, by a gradual rise to the Yellowstone plateau and solid lodgepole pine types on the southeast, and by the Yellowstone River on the west and north. It was considered a natural biological unit for budworm treatment because of open grassland type and the high mountain barriers which surround the unit.

Variations in timber types and elevations are extreme. The unit is not in a clearly defined forested area. In common with other forest lands east of the Continental Divide most of the land area is a mixture of grasslands and trees or rock outcroppings and trees. The north slopes generally support the more dense areas of tree growth and the southerly exposures contain a larger proportion of grassy or rocky land.

The topography is sharp. The canyon of the Yellowstone River is abrupt and deep. The side drainages of the Yellowstone River vary greatly in elevation, and in many areas the canyon sides approach the perpendicular. The fir types treated vary in elevation between 5,000 feet and 8,000 feet. The largest tract of land which is not severe in topographic features is that portion of Yellowstone National Park between Mammoth Hot Springs and Lamar Basin. This area is free of abrupt changes in elevation except for the river bed itself. The one large fast plane (TBM) on the project was assigned to this area.

Determination of Exterior Unit Boundaries

This job was done by the Forest Insect Research branch of the Forest Service. The starting point was the Spruce budworm survey map prepared during the summer of 1954. The map was made by air detection with lesser amounts of time spent on ground checking. The relative intensity of the current year defoliation and the mortality can well be determined by air mapping. The actual extent of the anticipated next years attack is a ground mapping job. Tree sections were taken from known infected areas and the crop of budworm larvae determined by putting these tree sections in the laboratory at room temperature. This test showed that a minor winter loss of larvae had occurred. The ground mapping job of the type boundaries was then started. The ground survey showed that the infected area was much larger than had been anticipated. The original estimated area in need of spraying was approximately 50,000 acres. The final estimated area in need of spraying was approximately 140,000 acres. Determination of the back line of the infestation was made difficult by a late spring. The snow on the higher elevations was two to three weeks late in melting and restricted the movements of survey crew members.

Interior Boundary Line Mapping

Interior boundary line mapping was started on June 20th. This was the first day that aerial pictures of the area were available to use as a mapping base. The broad divisions of type were mapped by the air in two flying days. The data was placed directly on the aerial prints which were provided. Some of the questions which arose on this mapping job were:

1. What is a practical sized area to exclude from spraying?
2. How will the pilot spray each individual area, that is, what will be his direction of flight and his approach on the particular topography encountered?
3. What size and quality of airplanes will be used on the spraying job?

Within the spray area exteriors, there are lodgepole types which do not require spraying. The fringes of the lodgepole types and the upper limits of fir types where they gradually merged with types which need spraying are very hard to define, even by experienced type mappers. Further, it was found that such borderline areas are very difficult to show to pilots who are going to do the spraying job. Usually topographic features such as rock outcroppings and grassy spots are much easier to use as spray borderlines. On the Gardiner Unit it so happened that the U. S. Geological Survey people were doing an intensive field mapping job at the time spraying was in progress. Their work had flagged quite a number of open points with substantial colored flags. These flags were excellent land markers for the pilots.

One of the difficulties peculiar to the project was that the best available map of the Yellowstone National Park area was on a small scale and quite old. It did not define present day highways or other cultural features. Reconciling this map with the Forest Service map to the north indicated that one or the other was seriously in error as to drainage pattern. Since the Park has no public land survey, there are no section corners or measured distances to tie to. An improvised grid was laid over the aerial prints to be used in determining Park areas and distances. A timber type map of the Park area was used to find the exterior boundaries and the general locations of Douglas fir stands. This type map was similar in accuracy and design to the grazing survey maps which were available on much of the National Forest maps to the north. When aerial mosaics were pieced together, it was found that the type map of the Park and the grazing maps on the National Forest lands were both so generalized they were of little value in the spraying operation. Both the timber type map and the grazing survey map were of value to the project until the time aerial prints were made available. Before prints were available, it was necessary that reports be made as to the number of acres to be treated. The interior mapping as well as the definite decisions as to what size and shape of grassland or non-infected types to exclude had to be finished before a total acreage figure could be obtained. An estimated 144,000 acres to be sprayed was decided upon on June 30th. The detailed mapping job on interior boundaries was done by air after the spraying work was begun. As the chief pilot was taken over the blocks to be sprayed and shown the boundaries, the refinements in mapping were completed. There was no ground work done in connection with interior boundary mapping. It is quite certain that many mistakes were made because of unfamiliarity with ground conditions.

Entomological Report

These reports were prepared by FIR personnel after first checking the developmental stages of the budworm larvae. Un-seasonably warm weather preceeded June 23rd. At that time very recent field checks had been made and the best possible estimate was that spraying would not be advisable prior to July 6th and more probably about July 10th. From June 23rd on the weather remained normal or slightly cooler than normal, but the larvae growth in the Gardiner unit was more advanced than expected and on June 29th the field checks revealed that the larvae were ready for spraying in the lower elevations. Further checks revealed that the larvae were ready to spray on June 29th on any area south of the Yellowstone River up to an elevation of approximately 6,000 feet.

This unexpected early development of the budworm larvae should be recorded as it is something that appears to have a bearing upon the hours of spraying, length of the spray season, and other control factors. The Gardiner Unit did not follow the time pattern which had been accepted up to that time. The larvae development came with a burst. Flying time likewise was very limited. It appears to the writer that this is due to the rocky and more open character of the spray area. A large solidly timbered tract holds much more spring soil dampness, allows less rapid heat build up during the day, and temperature fluctuations are more moderate. In short, forested regions where the canopy is mostly unbroken are a moderator of temperatures and climatic conditions. The Gardiner area is not forested in the sense that the western portion of the region is forested. The valley floor is generally barren of tree growth. Numerous openings and rock faces warm up quickly and retain heat longer than heavily timbered areas. Just as larvae development exceeded expectations, the usual wind and temperature ranges used for spraying were not good indicators in the Gardiner area. As the season advanced the spraying time became more and more restricted. The last two or three days of spraying were far from favorable even at the break of day with negligible winds and low temperatures. It appeared as though the usual falling air of early morning which disseminates the spray through the trees and to the ground was absent. Air currents were static (probably due to heated ground surfaces) and the spray itself took on a blue haze and hung in the air instead of settling with the desirable gentle downward air currents.

The last blocks sprayed during the 1955 season on the Gardiner unit were on the northern edge of the unit. An inspection showed that a considerable portion of the larvae had already incased themselves by the time the spray was applied. This portion was estimated as being within twenty to thirty per cent of the total budworm population. Nevertheless, spraying was done on the area to reduce the total budworm population as much as possible during the current season. Spraying operations were discontinued on July 20th. It is doubtful that a satisfactory job could have been done on any of the blocks within the unit after that date.

Spray Plane Equipment Used

The contractor on the project proposed to spray the area with Stearman planes. When the lesser acreage was the final goal for the year, a six-plane unit was proposed to handle the operation. Later when checks showed the size of the job to be more than doubled, more planes were necessary and the contractor furnished eleven Stearman Biplane Aircraft and in addition hired one TBM which had about five times the capacity for insecticide that was carried in the Stearman's. The larger plane was much faster in flight than the Stearmans

and not as maneuverable in rough topography. Consequently, the TBM was assigned to areas upon which the contractor thought it would have most success. This was the less precipitous area between Mammoth Hot Springs and the Lamar Basin within the Yellowstone National Park.

As the planes arrived, they were inspected by regional air safety officers and calibrated as to spraying equipment adequacy by Mr. Gieser and Mr. Isler of Beltsville, Maryland Experiment Station. The calibration inspection of equipment was not a particularly heavy job because all the planes used on the project had previously been spraying budworms and were well equipped for the job. The technicians from the Beltsville, Maryland station were extremely helpful to the project supervisor in the conduct of the whole spraying operation. They had had considerable experience in the routine of the job, the methods normally used by contractors, the shortcomings which might occur, and in general were helpful in their advice and inspections. The load limits to be carried by the Stearmans and the TBM were set at the time of inspection. The Stearmans presented something of a problem because their ratio of gasoline and insecticide was more critical than would be the case in larger planes. A system of easy checking to see that no pilot overloaded on insecticide was worked out and proved to be very satisfactory. The load of insecticide in the Stearmans varied from 100 to 125 gallons. Gasoline to the limit of the tank was ordinarily not carried. Early in the project it became routine for the pilot to load gasoline each time he loaded insecticide.

Insecticide Loading Equipment

The contractor furnishing the insecticide visited the site with the principals of the flying contract and the FIR people and the forest service representatives and a satisfactory loading station was agreed upon. Tanks were installed with slightly more than 20,000 gallons capacity. Three spray pipe lines with a nozzle on each were placed at great enough intervals for three planes to be serviced at once. Two pressure pumps were in use to keep hose line supplied and additional equipment was held on standby in event of motor failure or in event of pump failures. The insecticide was normally delivered before daylight for the day of operation. Due to the distance from the central mixing plant which was located at Missoula, orders for insecticide were ordinarily placed at noon of each day to provide ample supplies on hand at daylight the following morning. The loading of the Stearman planes was rather simple. The nozzle man at each station loaded the plane in one minute or less. The gasoline for the planes was supplied by the flying contractor from a tank wagon equipped with a long hose and nozzle. The loading of the TBM plane was slightly more complicated. A special fitting had to be used to make the connection with the tanks in the TBM plane. Since this fitting was attached to the nozzle supply, one nozzle was not usable in loading Stearman planes. The end result was that ten or eleven Stearman planes were being loaded by two nozzles and the one nozzle line was pretty much reserved for the use of the TBM plane. By and large, no disturbing or interfering factors arose insofar as the loading station or the delivery of insecticide into planes. Upon completion of the job, the pipe lines were drained and it was found that approximately 200 gallons of insecticide was tied up in the extreme bottom of the storage tanks and the pipe lines.

Project Safety Considerations

A. Field Travel Safety:

Field travel was performed by all members of the FIR organization and most of the members of the Forest Service organization. The greatest single hazard concerned with field travel was vehicular accidents. Roads used varied from U. S. oiled highway surfaces to dangerously steep and rugged primitive mountain roads. The second hazard to field traveling personnel was sprains and such accidents as might happen in walking through heavily wooded as well as rocky terrain. Poisonous snakes and other lesser hazards were also present. As far as is known, there were no accidents greater than slight abrasions to field traveling personnel. There were several near misses. One vehicle was lightly scraped by a heavy bus on a main highway. On occasion FIR personnel would be out far beyond their normal tour of duty. No near miss or accident causative agent was overlooked. Each was discussed and preventive action taken.

B. Air strip Personnel:

The air strip personnel were subject to much more violent accidents and many more hazards than were the field traveling personnel. A high degree of co-ordination and anticipation of other people's actions was necessary by all individuals at the air field to prevent accidents. Probably the most extreme danger was due to fires which may have occurred. There were no fires of any cause or any kind. The second most serious probable cause of accidents on the air strip was people on the runway surface. This was a very real danger because the Steerman planes used in the spraying operations could not see the area immediately ahead of their plane when they set in for a landing. Another important hazard was the dust blown by the propeller wash of the planes. The dust hazard was eliminated to a large extent on the runway by the application of three to four inches of coarse sand. However, in turning, the planes blew the fine silt soil over the field, personnel, and the main highway surfaces to such a degree that watchmen were a necessity on the main highway to prevent tourist travel accidents, and landing and take-off visibility was reduced to an unsafe level. The probability of fuel line troubles because of the dust was present and important. Vehicular hazards on the air strip were of little importance because of the light amount of travel. All vehicular travel was kept away from the landing strip. This proved to be a constant policing job and one which users of automobiles did not seem to appreciate. The CAA inspectors gave us authority to regulate the field travel as we wished during the period of actual spraying operations.

C. Flying Contractors Safety:

Since all personnel on the job were uninformed in the use of planes and the hazards which arise thereby, the details of landing pattern, taxiing of planes, and storage of planes were discussed with the flying contractor, the

CAA, and the regional aerial safety officer to reach an agreement on a workable safe operation. The landing pattern was most important. The details as worked out by the flying contractor for a landing pattern were safe and workable. Due to the human element they were not always followed. The contractor maintained a flight officer who knew the habits and flying capabilities of each pilot. The pilots had complete confidence in this flight regulation officer. This one factor, perhaps more than others, prevented accidents. Briefly the general scheme of landing and take-off was as follows:

Take-off planes and incoming planes would not be within 500 feet of each other in elevation. Take-off planes and incoming planes would not be within one-half mile of each other in horizontal position. No two planes would be under uncontrolled power on the landing strip at the same time.

By and large, these three underlying rules which were reduced to a landing pattern were sound and good. They were upset when a large plane (the TBM) was intermingled with the smaller Steermans in spraying operations. This was due to the change in wind velocities during flying time. The smaller steermans could land and take off on the established morning pattern even though the wind changed direction and became as strong as nine miles per hour with the incoming planes. Due to the longer runway necessary for the TBM, it could not land on the strip with a tail wind of over two or three miles per hour. Because of this, it happened on several days that the larger plane would need to shift landing from one way of the runway to the other during the morning spraying. When this occurred, the flight officer would have to hold the Steermans aloft while the TBM was coming in for a landing. Possibilities of an accident were greatly increased by this maneuver. When a near miss occurred, it was decided that when the TBM changed directions of landing, all Steermans would likewise change directions of landing. There was no way of transmitting this information to the Steerman pilots on their first trip after the change was made. This resulted in lost time, confusion, and more possibilities of accidents.

The visibility for planes is important. The Steerman planes used in spraying left a big blind spot in front of the pilot on take-off and landing which required that the landing space be clear from the time the pilot made his final bank to come in for a landing until he had his plane under control by the wheel brakes. The pilot, ordinarily when coming in for a landing, rolled his plane on its side to provide their last look at field clearance. Visibility in flight appeared to be good and formation flying was used on many occasions with apparent confidence by all concerned. The landing strip visibility was reduced on several occasions due to dust. The TBM plane in warming up created more air disturbance than the landing strip was built to withstand. This warming up period blew the gravel off the runway and blew the end of the runway itself away. Planes of this horsepower should have a very solid surface at the ends of the runway. Holding down the dust hazard is important from the fuel sediment standpoint as well as safety in landing and take-off.

On several occasions low ceilings were a hazard in flying. The pilots ordinarily were confined in their spraying job to the base of the cloud level. While this appeared to be stable air, in reality there was a good deal of turbulence within 500 feet of the cloud level. This turbulence combined with low level flying is another hazard which needs close attention.

Planes taxiing in and out of the landing strip had sufficient room to leave the strip and stay on the side of the field. When moving over this rougher ground, not covered by dust-holding sand coat, a good deal of dust was blown into the air which reduced visibility.

Private planes used the field on occasions before and after spraying operations. Had they come in for a landing during spraying operations, they would have created another hazard because of their unfamiliarity with the landing pattern in effect. Due to the distances between fields, it was probable that private planes would need to use the landing strip.

The traffic director was first provided with a battery powered flashlight with a red reflector cover. This proved ineffective to catch the pilots' attention and was finally discarded and a large white flag used in its place. Some device is needed to definitely catch the pilots' eyes and wave them off from landing. A more effective red light is probably the best solution for this.

Chronology of Spray Conditions

The first thing needed was to know the size of the job, the Forest Service responsibility, and the contractor's responsibility, so that an organization could be devised. Because of the newness of the project, the haste in which it was authorized, and the complete lack of experience by any of the personnel in air operations or spraying operations, one of the last things learned was the size of the job and the responsibility inherent with it. We started out with a project leader, an assistant project leader, a head clerk, and an expediter for the movement of the FIR employees. When it became known that the acreage was more than twice what was anticipated and the exterior boundaries of the control area moved out further distances, it was found that more people were needed to keep records on the increased number of planes. As the planes were delivered on the job by the contractor, inspectors for the aircraft and the calibration of spray were on hand to pass on the adequacy of these two features.

We knew that weather data and communication would be important on the project. A station was established on the northern end of Yellowstone Park on Crevice Ridge in a Park guard station. Weather instruments were put up and a weather man installed on the job. He was equipped with an SPF radio which we found would not function between the landing strip and the weather station by direct contact, so an intermediate weather man was established at the headquarters of the Forest Ranger Station at Gardiner to relay weather reports between the air strip and the outpost weather station. The location of the outpost station could not very well be moved because to do

so would have meant camps, camping facilities and accommodations for the outpost weather man. Time was too short and personnel was not available to do this. This outpost station was intended to give us reliable data for spraying because it was located in the fir types at the thermal belt in the approximate center of the spraying area. Through use of the station, we found that no one weather station location is an accurate criterian for spraying conditions. Communication between the landing strip and outside was made by radio to the Gardiner Ranger Station office. Again time and personnel were too limited to allow the installation of an emergency phone line between these points. Radio communication was satisfactory. It was found, through testing, that high frequency walkie-talkie sets were not effective or reliable even between very close points where we assumed there would be no doubt as to their effectiveness.

The closest reliable records regarding day to day weather data for the spray area were those obtainable from the Boise office of the Weather Bureau. This office has been supplying Yellowstone Park with their fire data for some time and the weather bureau chief made a trip to Yellowstone Park at the time spraying was about to begin. Mr. Barrows of the Yellowstone Park organization brought this man down to our project, acquainted him with topography, and it was decided that he would provide us with a daily forecast from readings given him on previous days' wind velocity directions, temperatures, and cloud ceilings. The results of the weather data thus provided were very good. He could predict temperatures, wind directions, cloudiness, and other aspects to a very high degree. It so happened that this was still not a close enough prediction to be useful in spraying operations.

All of the personnel on the job were new to a project of this kind. The contract was studied carefully with the idea of setting up records which would give us control of the job. In this respect the counsel and guidance of Mr. Gieser was most helpful. He had had experience with the contractor and with a variety of other spraying jobs and was familiar with their way of doing business. We found that more help would be needed on the air strip to keep necessary records and received some good counsel and ideas on the practical limitations of control of the spraying job.

After the total area to be sprayed was determined to approximate acreage, a study was made of the contract to devise the records needed on the job. Some of the records agreed upon for use are summarized below:

1. A daily record of observation plane use.

2. A daily record of insecticide delivered to the air strip.

3. A daily record of the pilots and plane inspections.

4. A daily record of the distribution of insecticide by blocks.

5. A summarization of the safety features for each trip, for each plane, the size of the land, and the distination of the load.

6. A record of fire inspections and safety inspections of the landing strip working area, ambulance equipment, and fire equipment.

7. Daily time records of personnel.

8. Records of reports from FIR personnel.

9. Daily weather records for later analysis.

These separate records were made into forms to minimize the amount of writing to be done on the job. After the operations began, we found that other cumulative records of spray delivered to blocks, of the amount of spray delivered by each pilot each day and the number of trips made, supply tank inventories, meter readings, and various other lesser daily records, had to be kept. After the chief pilot arrived on the job, the observation plane was used to give him a general idea of the backline of the job and to get his idea as to how the blocking could best be done to serve his needs and the pilots use. It was found that the aerial mosaics which had been used as a mapping base for mapping areas to be sprayed and not to be sprayed had not been done with enough detail to be useful on this job. The chief pilot for the contractor became generally acquainted with the area and his wishes as to blocking and assignments were generally followed. On those areas where drainage features were indefinite and timber types were involved, we found that a clear definition of block lines, areas to be sprayed and areas not to be sprayed was difficult information to get to the chief pilot and from the chief pilot to the spray pilots. The project leader worked almost entirely with the chief pilot in defining blocks and spray and non-spray areas. The chief pilot in turn, took the spray pilots over their respective assignments to get them familiar with their assignment.

It was found that one person at the air field was needed to record weather data almost exclusively. Weather reports were relayed every fifteen minutes and readings were taken at the air strip on wind and temperature every fifteen minutes. Readings were taken at the outpost weather station every fifteen minutes and, in addition, weather data was taken by a mobile unit as often as it was possible for him to communicate with the air strip. This occupied the full time of one man at the air strip, one man on the relay station, one man at the outpost weather station, and one man on the mobile weather station.

The records on insecticide delivery, plane time out, and all other spraying operations were kept by the man who supervised the loading activities with the help of one other individual. Quite often two or three planes were loading at the same time. A careful check was needed to see that the pilots carried sufficient gasoline, that they did not carry an over amount of insecticide, and that the destination and time of departure was recorded for each trip. The handy-man of the Forest Service organization crew was on

the job to expedite the movement of FIR checkers to and from their checking strip lines. Actually he was used very little for this purpose. The FIR had their own motor transportation and only during periods when foot or horse travel was used did the Forest Service packer-truck driver help with the movement of FIR people. At other times this man became a relief man or third checker at the loading stations, did some aerial observations on the checking of spray effectiveness, and carried the assignment of getting a pictorial record of the job, and in general was a relief man or handy-man to fill in wherever his services were required.

The air strip was newly constructed on a tract of river flat which had been used as a local landing field for several years. A survey of the area indicated that this site could most easily be made into a useable landing strip. It was located very near the center of the spraying operations and was ideal from a plane ferrying standpoint. After the first large plane landed, we found that a sand cover or oil cover was needed to prevent the dust hazard. A thin coating of oil was laid over the sand cover to hold it in place around the loading area. Constant maintenance was needed on the air strip. If a hole developed in the landing strip and the plane's wheels ever disturbed the underlying silt and clay, we would have been without a landing space in a matter of minutes. Therefore, to spray, it was necessary that no breakup of top occur on the landing strip. This required watering, rolling, grading, and dragging of the strip, plus the constant maintenance during spraying operations of small chuckholes by two men assigned to that job. During one period in the life of the job, the top of the landing mat dried out to the point where it began to break up badly. Special attention and a special man with a maintenance crew was then assigned to the maintenance of the field as his sole responsibility and further breakups were prevented.

The hours of spraying were generally less extended than were expected. Advice from other spraying jobs indicated that spraying might be conducted up to the point of critical temperatures and critical wind velocities. Aerial observation showed that the only reliable place to measure temperature and wind is at the point where the spray is actually being applied. Since the spray was being applied on many widely distant areas at the same time, the most positive check on the effectiveness of spraying was to observe the fall of the spray from the planes. Quite often certain drainages would be unsatisfactory for further work when some blocks twenty or thirty miles away were still suitable for spraying. Every advantage had to be taken of all possible spraying time to complete the project. It was common to route spray planes from their assigned block to another block where the spray was still being effectively distributed. Examination of the weather records shows that only on one or two days was spraying possible up to the commonly accepted limits of temperature. The combination of rock outcroppings and open grass spots probably accounts for this lack of uniformity with other spraying jobs.

There was no communication between the observation plane and the air strip. On any observation flight it was necessary to come in and land to instruct pilots in their new assignments or changes in assignments. Generally, the time when spraying was not effective was determined by the spray pilots themselves. They were very cooperative in advising the chief pilot and the project men when they did not think they were doing a satisfactory job. Since these pilots were working on a gypo basis, that they were paid for every gallon of spray delivered, we can generally assume that they stretched the upper limit of spray time as much as possible in order to increase their day's pay. The record of time on flights as shown in the appendix, table two, shows that the average day's spraying from the time that the first plane left the ground until the last plane left the ground was three hours and sixteen minutes. A good portion of this time is normally lost because the first plane off the ground in the morning was in many instances testing air turbulence and other planes did not leave the ground for fifteen or twenty minutes. Ordinarily the observation plane was off the field before daylight with the intention of testing the air and getting back on the field in time to warm up the other planes and get them in the air as soon as visibility permitted. Toward the latter part of the morning spray periods usually some more time was lost because of one pilot waiting on the ground for instructions from the chief pilot as to the suitability of continuing or discontinuing spraying operations. Since some blocks were more favorable for late hour spraying than other blocks, the difference in time between the first plane out and the last plane out is not a good measure of the average spraying time available. A twenty percent reduction for factors shown above would seem proper. This would reduce the average desirable spraying time for the Gardiner 1955 season to two hours and thirty-seven minutes. The weather in general was considered to be better than average for spraying operations. Slightly less favorable conditions could be expected in an average year.

The correlation of activities with the FIR crew was generally very satisfactory from the Forest Service point of view. The job of checking the adequacy of spray was very difficult and had to be done with a good deal of personal judgment and personal knowledge and observation of the spray pilots. The most desirable procedure would have been for the Forest Service personnel to advise the FIR personnel at least two or three days in advance as to when and how a particular block was to be sprayed. The spraying time was limited to the extent that this could not be carried on with any degree of refinement. For example, we would have pilots working in an inaccessible block twenty miles from Gardiner on one day and the next day, due to weather conditions, this pilot would not go to his intended next-in-order block, but may be sent to some area twenty miles in the opposite direction because the block was suitable for formation spraying, because he was familiar with it, or for some other reason. The availability of an area for spraying was limited during the first two or three days by elevation boundaries. This was somewhat of a handicap in blocking because elevation lines are indefinite to the pilot. After the spraying operations progressed a few days, we

obtained clearance to spray large generalized areas. When this became possible, the chief pilot had more latitude for assignment of spray planes and with it a chance to do a better job of instructing pilots.

Card checking such a large area in so short a space of time is a very difficult, if not impossible, task with the limited personnel available. Means other than card checking were used to test the fall of spray. Markings on foliage and dead insects appeared to be reliable criteria. One morning some spraying was done in a light rain. This was in the Tower Falls area where the campgrounds had been cleared of campers and cars were removed and parked on the prairie and arrangements had been made by the Park Service to close the roads. It later developed that respraying a part of this area was needed. Respraying was also needed on five other blocks due to skips found in the spray pattern by checkers. In general, it can be said that the cooperative effort between the FIR and the Forest Service personnel was toward a common goal of getting the best possible job between the time limits set by weather conditions.

There are several special considerations on the projects. By far the greater portion of the area sprayed is wild land, uninhabited and not disturbed in any manner by the spraying. The small portions of the Gardiner area which required special attention were:

1. The Mammoth Hot Springs headquarters area.

2. The limited number of ranch homes and operations within and adjacent to the fir types.

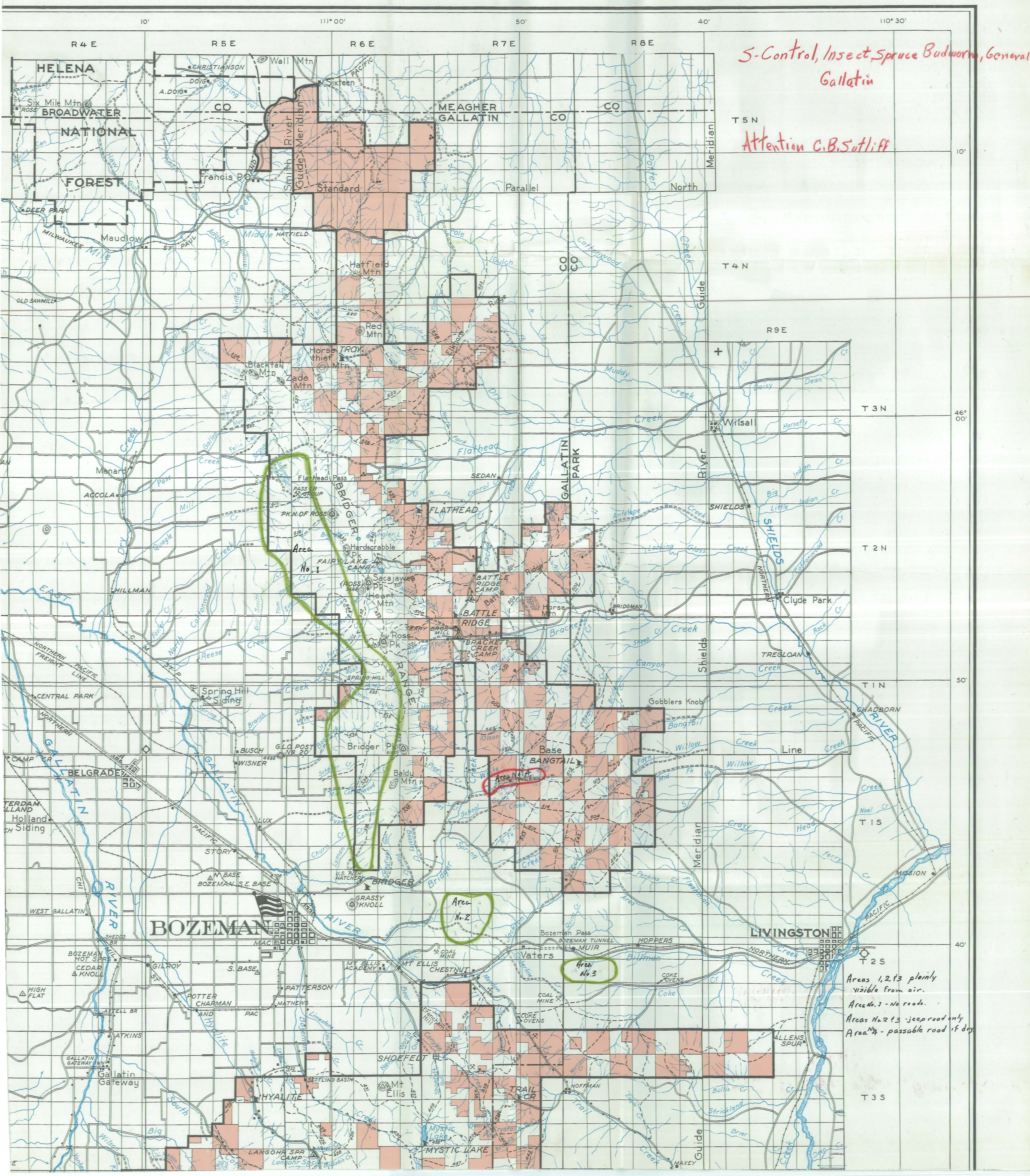
3. The highways within the fir types within Yellowstone National Park which are traveled by a great number of people.

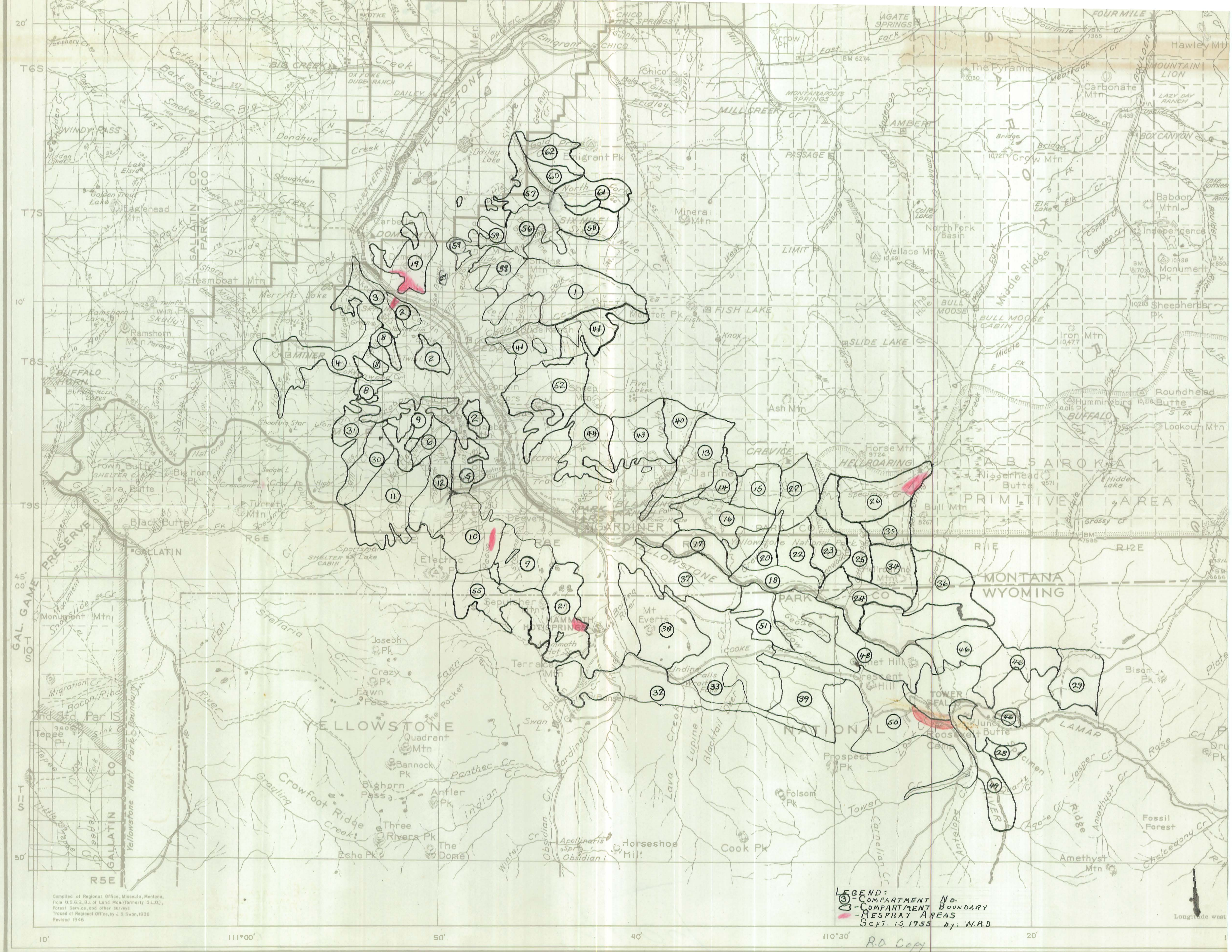
It was the desire of Park personnel that traffic be stopped on the highway between Mammoth Hot Springs and Tower Falls during the time spraying was in progress. Accordingly, we arranged to spray the road area and a sufficient control strip on each side of the road area in as short a time as possible. The schedule had been prearranged and eight Steerman planes were used in spraying the Mammoth Hot Springs-Tower Falls roadway area. Three planes flew in formation on each side of the road and two planes stayed aloft to fall into formation should any of the six planes run out of insecticide or for one reason or another have to fall out of formation. This procedure worked very well on the roadway margins except that some time was lost in grouping for formation flying at the beginning of the course and a good deal of disturbance was caused thereby because the grouping had to take place next to the hotels, restaurants, and administration buildings of Mammoth Hot Springs. Eight planes circling in formation were a disturbing early morning noise to the residents there.

Special consideration was given to a very careful job of spraying around the water system of Mammoth Hot Springs as well as the timber immediately adjacent to the Spring terraces and buildings. In the Tower Falls district the cars and campers had to be moved out of the fir types, again by pre-arrangement, so that spraying could be done at a set time without damage to their cars. A small campground in Slough Creek likewise had a few campers and on this occasion we did not spray according to a schedule which had been arranged and it is suspected the campers were in the timber during spraying operations. As far as is known, there were no adverse comments because of the spraying operations and people took the inconvenience in a good natured way.

There were no bees or other insects known to be cultured within the spraying unit. The greatest damage known was the disfiguration of flowers at the OTO Ranch with some damage to the hay crop at that ranch.

The Park personnel were very cooperative in the entire spray program. Mr. Barrows was constantly co-ordinating the work in the Park with our plans.


S-Control, Insect, Spruce Budworm, General
Gallatin
Attention C.B. Sutliff
Areas 1, 2, & 3 plainly visible from air.
Area No. 1 - No roads.
Areas No. 2 & 3 - jeep road only
Area No. 4 - passable road if dry.
Area No. 1
Area No. 2
Area No. 3
Area No. 4
R4E
R5E
R6E
R7E
R8E
R9E
T5N
T4N
T3N
T2N
T1N
T1S
T2S
T3S
HELENA
BROADWATER
NATIONAL
FOREST
MEAGHER
GALLATIN
BRIDGER
RANGE
GALLATIN
PARK
BOZEMAN
BELGRADE
LIVINGSTON
Wilsall
Clyde Park
Bozeman Pass
Flathead Pass
Bridger Pk
Sacajawea Pk
Ross Pk
Hatfield Mtn
Gobblers Knob
Mt Ellis
Mystic Lake



LEGEND:
③ - COMPARTMENT NO.
- COMPARTMENT BOUNDARY
- RESPRAY AREAS
Sept. 15, 1955 by: W.R.D.
R.O. Copy
Compiled at Regional Office, Missoula, Montana,
from U.S.G.S., Bu. of Land Man. (formerly G.L.O.),
Forest Service, and other surveys
Traced at Regional Office, by J. S. Swan, 1936
Revised 1946
YELLOWSTONE
NATIONAL
PARK
MONTANA
WYOMING
GARDINER
MAMMOTH HOT SPRINGS
ABSAROKA PRIMITIVE AREA
GALLATIN CO
PARK CO
GAL. GAME PRESERVE
Yellowstone Nat'l Park Boundary
T6S
T7S
T8S
T9S
T10S
T11S
R5E
R6E
R8E
R11E
R12E
111°00'
110°30'
Longitude west
CHICO
Emigrant
Emigrant Pk
SIX MILE
Mineral Mtn
FISH LAKE
SLIDE LAKE
Ash Mtn
CREVICE
HELLROARING
Horse Mtn
Jardine
Electric
Sepulcher Mtn
Mt Everts
Bunsen Pk
Tower Falls
Roosevelt Camp
Junction Butte
LAMAR
Prospect Pk
Folsom Pk
Cook Pk
Horseshoe Hill
Obsidian L
Three Rivers Pk
The Dome
Echo Pk
Bighorn Pass
Antler Pk
Bannock Pk
Quadrant Mtn
Crazy Pk
Joseph Pk
Swan L
Crowfoot Ridge
Amethyst Mtn
Fossil Forest
Bison Pk
Crown Butte
Lava Butte
Black Butte
GALLATIN
Big Horn Pk
Turrett Mtn
Steamboat Mtn
Ramshorn Mtn
Twin Pks
WINDY PASS
BUFFALO HORN
Shooting Star
Monument Mtn
Tepee Pt
BIG CREEK
Dailey Lake
The Pyramid
Carbonate Mtn
MOUNTAIN LION
Hawley Mtn
FOUR MILE
AGATE SPRINGS
Chico Pk
MILL CREEK
AMBERT
PASSAGE
Crow Mtn
LIMIT
Wallace Mtn
North Fork Basin
BULL MOOSE
Baboon Mtn
Independence
Monument Pk
Sheepherder Pk
Iron Mtn
Hummingbird
Roundhead Butte
Lookout Mtn
Niggerhead Butte
Bull Mtn
Hellroaring Mtn